



Berner Fachhochschule
Haute école spécialisée bernoise
Bern University of Applied Sciences



EU PVSEC

Ultrafast Multi-MPPT PV Inverter Test Bench

Prof. Urs Muntwyler, Daniel Gfeller
Bern University of Applied Sciences

Partners



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra



► PV-Lab

Topics

- ▶ Inverter Testing – What’s Important?
- ▶ Common Problems with PV Array Simulators
- ▶ PV Inverter Testing at Bern University of Applied Sciences
- ▶ The new Multi-MPPT PV Inverter Test Bench
- ▶ Conclusions and upcoming activities

Building “Tiergarten”, home of BFH-TI’s PV lab in Burgdorf, Switzerland.



Inverter Testing – What's Important?

3 Things needed for Inverter Testing:

Precise Measurement Equipment

→ No Problem, if you got the Money.

Good Quality PV Array Simulator

→ **This one is trickier than one might think. Let's hear more about it!**

Know-how & Experience

→ This belongs into another presentation...

Inverter Testing – What's Important?

High Speed

Solar modules have a fast transient response. A good simulator should behave the same way.

High Stability

Essential for reproducibility. Because of this, real PV arrays are not suitable for testing.

Good Quality PV Array Simulator

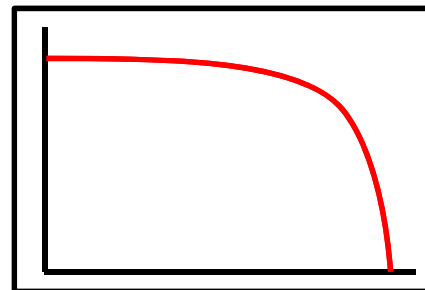
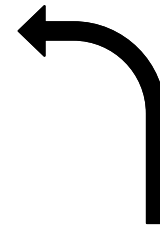
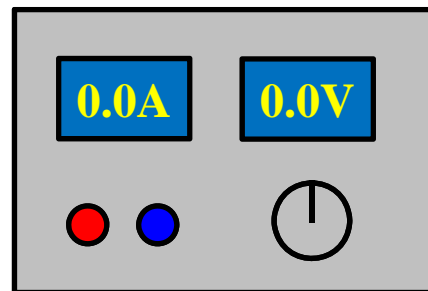
Low Noise

The simulator should not affect the D.U.T. or the measurement equipment. Especially not, if you are measuring the D.U.T.'s electromagnetic interference.

Common Problems with PV Array Simulators

**Most commercially available
PV Simulators work like this:**

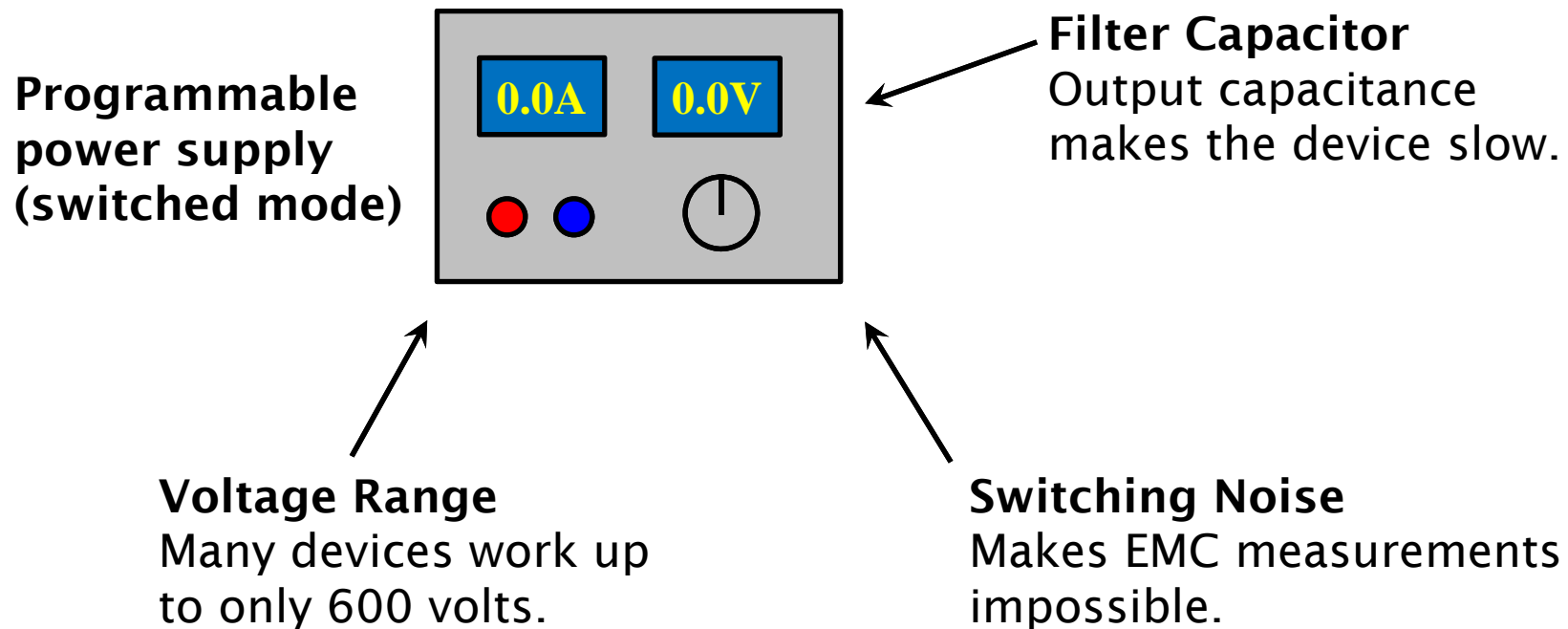
**Standard
programmable
power supply
(switched mode)**



**IV curve generation
by software option
or additional control
hardware**

Common Problems with PV Array Simulators

**Most commercially available
PV Simulators work like this:**



Common Problems with PV Array Simulators

Many commercially available PV array simulators emulate the DC characteristics of a PV array very well.

Often there are major differences between the AC characteristics of these simulators and the characteristics of a real PV array. Also, such simulators often generate a considerable amount of switching noise which can compromise the measurement.

Conclusion

A cheap way for rudimentary tests of PV inverters.

Not suitable for a realistic & reproducible test environment.

Inverter Testing at Bern University of Applied Sciences

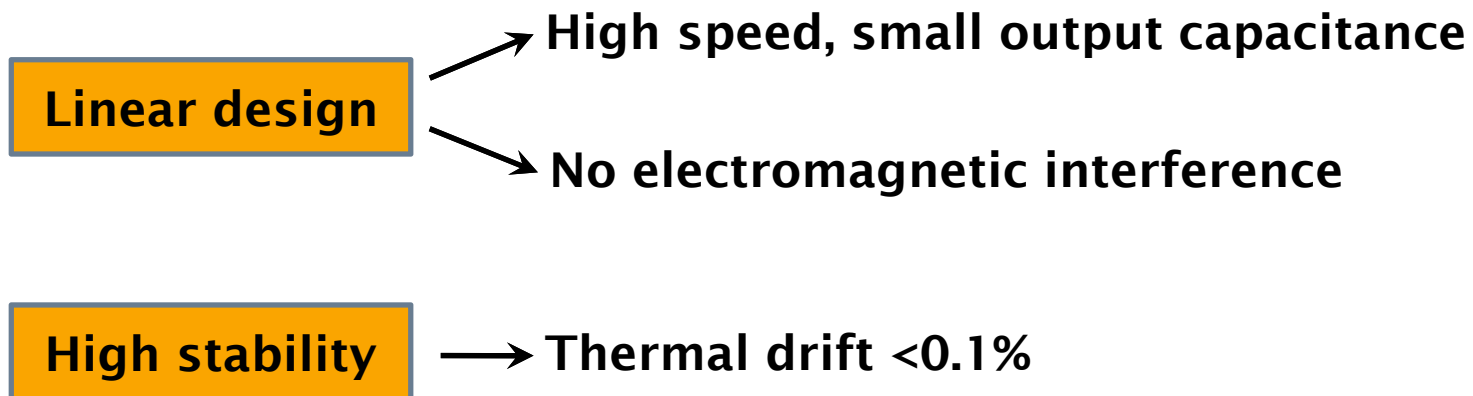
- ▶ The pv lab of BFH-TI has more than 20 years experience in testing of PV inverters.
- ▶ As there were no simulators available in the early nineties, first tests were performed with real PV arrays.
- ▶ After having made bad experiences with an industrial simulator, the pv lab developed its own PV array simulator (25 kW) in 1999.
- ▶ In 2001, an improved simulator of 20 kW became operational.
- ▶ In 2009 the construction of our PV array simulator of 100kW was finished. At this time, this was probably the most powerful simulator in the world.



**BFH-TI's 100 kW PV array simulator shortly
before it became operational in 2009**

Inverter Testing at Bern University of Applied Sciences

What makes our simulators special?



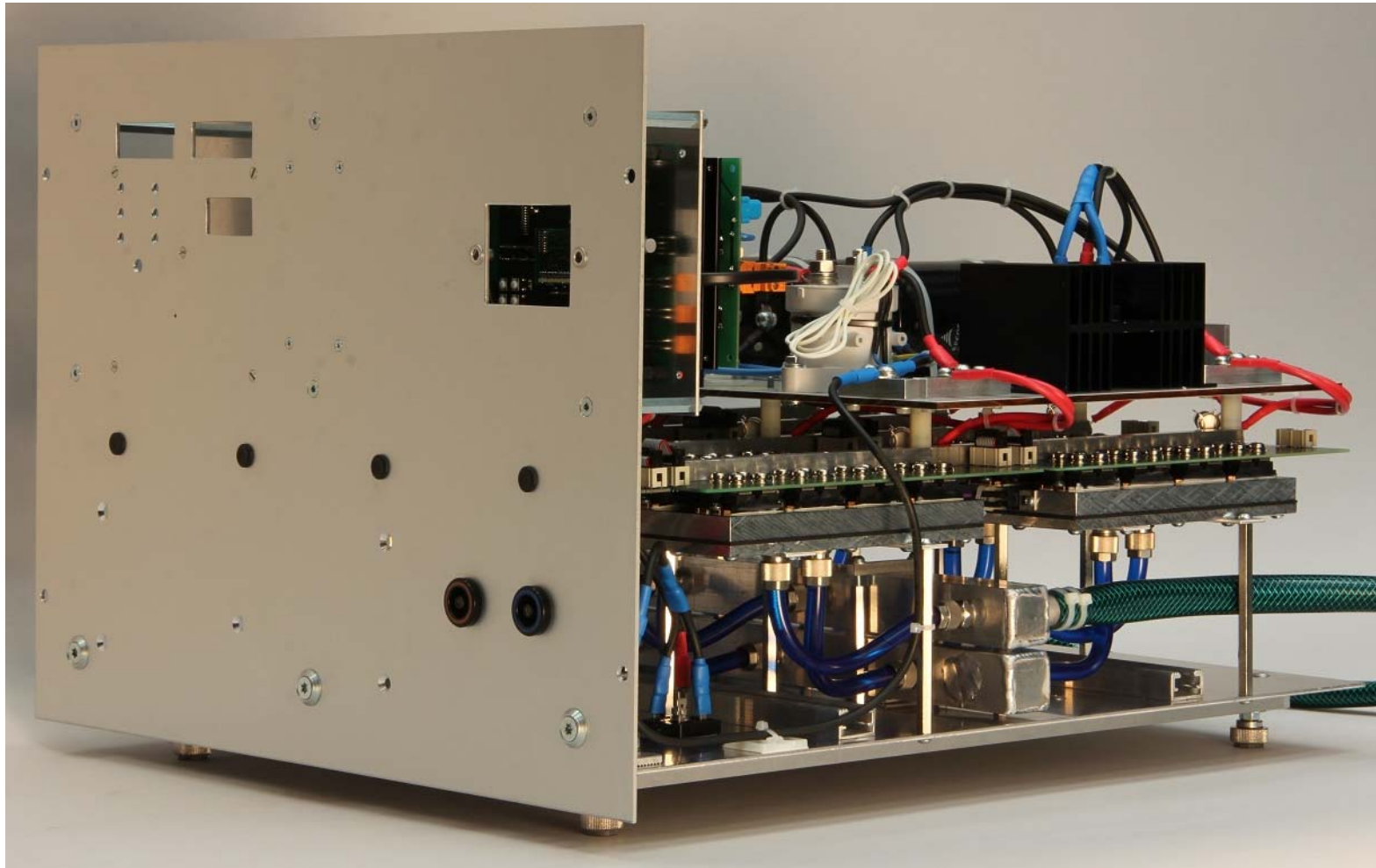
The new Multi-MPPT PV Inverter Test Bench

- ▶ In summer 2013, construction of a PV array simulator for testing of multi-MPPT inverters began.
- ▶ The design is inspired by our existing simulators. All the same, it is a complete redesign.

Projected technical data

Topology:	3 linear, individually programmable, liquid cooled sub array simulators
Voltage range:	0...1000VDC
Output Power:	3 x 11.52kW (FF = 72%) 3 x 12.8kW (FF = 80%)
Thermal Drift:	< 0.1%
Settling Time:	< 100μs

The new Multi-MPPT PV Inverter Test Bench



Prototype of a sub array simulator (under construction)

The new Multi-MPPT PV Inverter Test Bench

Challenges of a 1'000V linear Design

- ▶ Only very few high voltage linear semiconductors are available
- ▶ Most don't have a 1'000V rating
- ▶ Peak power dissipation of 16kW per sub array simulator
- ▶ Liquid cooling required



← Liquid cooled heatsink for the multistring-simulator

Conclusions

- ▶ The construction of a good quality PV array simulator is an often underestimated problem.
- ▶ Most commercially available simulators have unrealistic AC characteristics and can cause EMC problems.
- ▶ BFH-TI's PV array simulators have a linear design, resulting in very good AC and DC behaviour with no switching noise.

Upcoming activities

- ▶ The new multi-MPPT PV inverter test bench will be operational by Spring 2015.
- ▶ Accreditation of the existing 100 kW and the new multi-MPPT test bench, making BFH-TI's PV lab to Switzerland's only test institute able to carry out certified tests on PV inverters.
- ▶ You are welcome to test your PV inverters and/or MPPT charge controllers at BFH-TI's PV lab!

Thank you for your time!